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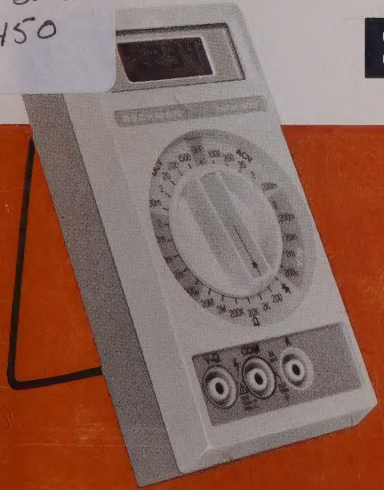

SERIES 300
HAND HELD
Digital Multimeters

SERIES 300 DIGITAL MULTIMETERS
OPERATOR'S MANUAL
FOR
HANDHELD MODELS

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Beckman Electronics Technologies • Brea, California 92621

Beckman Instruments, Inc. Fullerton, CA 92634
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WARRANTY

ONE-YEAR LIMITED WARRANTY

Series 300 Digital Multimeters are warranted in entirety against any defects of material or workmanship which develop for any reason whatsoever, except abuse, within a period of one (1) year following the date of purchase of the multimeter by the original purchaser. This warranty is extended by Beckman Instruments, Inc. (Beckman), only to the original purchaser or original user of the multimeter, who must, as a CONDITION PRECEDENT TO WARRANTY COVERAGE AND PERFORMANCE THEREUNDER BY BECKMAN, complete and return the Warranty Registration Card, received on purchase of the multimeter.

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Brea, CA 92621
Attention: Customer Service

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BECKMAN INSTRUMENTS, INC.
Fullerton, California

Dear Customer:

Congratulations on the purchase of your new Beckman Digital Multimeter! Beckman Instruments, Inc., a leading international manufacturer of laboratory analytical instruments, process instruments, and precision components, has extended its knowledge and skills into the production of the Series 300 Digital Multimeters. Because of the time and care taken in the design and manufacture of your multimeter, we are sure that you will enjoy the use of it for many years to come.

Beckman Instruments, Inc.

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SECTION ONE

INTRODUCTION

The Series 300 Digital Multimeters are completely portable, 3½-digit multimeters with liquid-crystal-display (LCD), designed for use by the engineer, technician, or hobbyist who demand a multimeter that is accurate, reliable and always ready for use. Equipped with seven functions and 29 ranges (27 ranges on the TECH™ 300 Model), each test position on the multimeter is quickly and easly selected with a simple turn of the single selector switch. Small enough to fit in most attache cases and equipped with a multiposition tilt stand, Beckman Series 300 Multimeters are equally suited for design engineering, production testing, field servicing, and industrial maintenance applications.

In addition to the features described above, all Series 300 Multimeters—except the TECH 300 Model—also offer two particularly useful, yet uncommon digital multimeter features: Insta-Ohms® Quick Continuity Indicator, and ten ampere AC/DC current measurement capability.

The TECH 330 Model has the added capability of measuring both AC voltage and current in true RMS. True RMS permits accurate measurement of even the nonsinusoidal waveforms typically found in the switching power supplies, motor speed controllers, SCR regulators, and digital systems. The direct-coupled inputs of the TECH 330 Model permit direct measurement of the total (AC + DC) RMS value of complex or simple AC waveforms.

The Series 300 Multimeters include all of the following features as standard:

SUPERIOR RELIABILITY

To ensure high reliability, Beckman designed a custom CMOS large-scale integrated circuit to eliminate most discrete components. Because all active multimeter functions are performed by this one integrated circuit, the total number of electronic parts in the basic multimeter has been reduced. Reliability is further enhanced by 100 percent burn-in of each multimeter and complete factory test of every function and range.

GUARANTEED LONG-TERM ACCURACY

Specified accuracies are guaranteed for a full year with a single calibration adjustment on the averaging models and only four adjustments on the TECH 330 Model. Long term accuracy is assured through the use of an extremely stable, band-gap reference element and Beckman thin-film register networks.

RUGGEDNESS
Beckman Multimeters are designed to give years of trouble-free operation under heavy duty use. The liquid-crystal-display and single rotary switch are both recessed to prevent damage while in a tool box or on the job.

OVERLOAD PROTECTION
All inputs are protected against *continuous* overload conditions beyond the capability of the multimeter that may result from the measurement of unknown signals or from operator error. Also all voltages and resistance ranges are protected against voltage transients up to six KV, ten microseconds duration by metal-oxide-varistors.

EASE OF USE
A single switch turns on power and selects both function and the desired range. The liquid-crystal-display is easy to read both indoors and outdoors, even in direct sunlight.

IN-CIRCUIT RESISTANCE MEASUREMENTS
All resistance ranges are low-power ohms which allow accurate measurements of in-circuit resistance. Because test voltages are held to less than 250 mV, accurate measurements may be made even in circuits where resistors are directly shunted by typical silicon diodes and transistors.

DIODE TEST FUNCTION
A special diode test function allows accurate measurements of forward voltage drops across diodes and transistor junctions, even in circuits where semiconductors are directly shunted by resistors.

BATTERY LIFE
One standard nine-volt transistor battery provides up to 2000 hours of continuous operation. Under typical use, a battery should last two years.

LOW BATTERY INDICATOR
The decimal point in the Digital Display begins to blink when approximately 200 hours of battery life remain.

VERSATILE
Small, lightweight, and completely portable, the multimeter has a handy tilt bail for easy positioning and antiskid pads to keep it in place. Perfect for field, lab, or home use.

COMPLETE AND READY TO USE
Multimeters are shipped with battery and fuse installed. Remove the multimeter from the box and it is ready to use. Also included with each multimeter is a spare fuse, TL-242 Probe Set, and a complete operation manual.

1.1 TECH 300 MODEL

The TECH 300 Model has all the features just described, *excluding* the Insta-Ohms Quick Continuity test function and ten ampere AC/DC current ranges. It has an accuracy of ±0.5% of reading in DC volts.

1.2 TECH 310 MODEL

The TECH 310 Model has all the features just described, including the Insta-Ohms Quick Continuity test function and ten ampere AC/DC current ranges. It has an accuracy of ±0.25% of reading in DC volts.

1.3 TECH 310 UL MODEL

The TECH 310 UL Model has all the features just described, including the Insta-Ohms Quick Continuity test function and ten ampere AC/DC current ranges. It has an accuracy of ±0.25% of reading and is Underwriters Laboratories rated.

UL LISTED 594Z

1.4 TECH 320B MODEL

The TECH 320B Model has all the features just described including the Insta-Ohms Quick Continuity test function and ten ampere AC/DC current ranges *plus* audible indication of continuity. It has an accuracy of ±0.1% of reading in DC volts.

1.5 TECH 330 MODEL

The TECH 330 Model has all the features just described, including the Insta-Ohms Quick Continuity test function and ten ampere AC/DC current ranges plus the capability of measuring AC signals in true RMS. It has an accuracy of ±0.1% of reading in DC volts.

NOTE

The symbol ⚠ *on the front panel of the multimeter is an international symbol meaning "REFER TO OPERATING INSTRUCTIONS." Warnings and precautions to avoid personal injury and multimeter damage are listed in Paragraph 4.1.*

Specifications are subject to change without notice.

2.1 GENERAL

The following specifications apply to the Series 300 Digital Multimeters.

OPERATING TEMPERATURE RANGE
0 °C to + 50 °C

STORAGE TEMPERATURE RANGE
– 40 °C to + 65 °C with battery removed

DISPLAY
3½-digit and liquid-crystal-display (LCD) with a maximum reading of 1999

POWER
Single, standard nine-volt battery, NEDA 1604

BATTERY LIFE
Alkaline: 2000 continuous hours, nominal
Zinc-Carbon: 1600 continuous hours, nominal
Under typical usage: two years

LOW BATTERY INDICATOR
Decimal point in Digital Display blinks with 200 hours battery life remaining

SHOCK AND VIBRATION
Meets MIL-T-28800 specifications

RELATIVE HUMIDITY
0% to 80%, 0 °C to 35 °C; 0% to 70%, 35 °C to 50 °C

TEMPERATURE COEFFICIENT (0 °C to 20 °C, 30 °C to 50 °C)
Less than 15% of applicable accuracy specification per °C

MAXIMUM COMMON MODE VOLTAGE
1500 VDC or peak AC

DIMENSIONS
6.85 inches (17.4 cm) long x 3.65 inches (9.3 cm) wide x 1.8 inches (4.6 cm) high

WEIGHT
16 ounces (454 grams) including battery

CALIBRATION
Accuracy specifications guaranteed for one (1) year, 25 ± 5°C

MEASUREMENT RATE
Four measurements per second, nominal

CASE
High-impact ABS plastic, fire retardant

MULTIMETER INCLUDES:
1. Nine-volt battery
2. Spare fuse (Except TECH 320B Model)
3. TL-242 Probe Set
4. Operator's manual

2.2 DC VOLTS

The following specifications apply to the Series 300 Models, unless otherwise indicated.

		ACCURACY (1 YEAR, 20°C to 30°C)		
RANGE	RESOLUTION	TECH 300	TECH 310	TECH 320B, TECH 330
± 200 mV ± 2 V ± 20 V ± 200 V ± 1500 V	100 µV 1 mV 10 mV 0.1 V 1 V	± (0.5% reading + 1 digit)	± (0.25% reading + 1 digit)	± (0.1% reading + 1 digit)

TECH 310 UL		ACCURACY (1 YEAR, 20°C to 30°C)
RANGE	RESOLUTION	
± 200 mV ± 2 V ± 20 V ± 200 V ± 750 V	100 µV 1 mV 10 mV 0.1 V 1 V	± (0.25% reading + 1 digit)

GENERAL
Automatic polarity indication (+ and − indicated)

INPUT IMPEDANCE (ALL RANGES)
22 megaohms

NORMAL-MODE REJECTION
Greater than 60 dB above 49 Hz

COMMON-MODE REJECTION
Greater than 160 dB up to 1500 VDC

RESPONSE TIME
Less than one second

OVERVOLTAGE PROTECTION
1500 VDC or peak AC, any range; six kV transients, ten micro-seconds duration

2.3 AC VOLTS

The following specifications apply to the Series 300 Models, unless otherwise indicated.

TECH 300		ACCURACY (1 YEAR, 20°C to 30°C)		
RANGE	RESOLUTION	45 Hz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz
200 mV 2 V 20 V 200 V 1000 V	100 µV 1 mV 10 mV 0.1 V 1 V	±(1.5% reading + 4 digits)	±(2.0% reading + 5 digits)	±(3.0% reading + 9 digits)

TECH 310 UL		ACCURACY (1 YEAR, 20°C to 30°C)		
RANGE	RESOLUTION	45 Hz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz
200 mV 2 V 20 V 200 V 500 V	100 µV 1 mV 10 mV 0.1 V 1 V	±(0.75% reading + 3 digits)	±(1.5% reading + 5 digits)	±(2.5% reading + 9 digits)

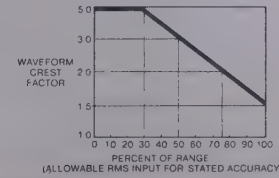
TECH 310		ACCURACY (1 YEAR, 20°C to 30°C)		
RANGE	RESOLUTION	45 Hz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz
200 mV 2 V 20 V 200 V 1000 V	100 µV 1 mV 10 mV 0.1 V 1 V	±(0.75% reading + 3 digits)	±(1.5% reading + 5 digits)	±(2.5% reading + 9 digits)

TECH 320B		ACCURACY (1 YEAR, 20°C to 30°C)		
RANGE	RESOLUTION	45 Hz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz
200 mV 2 V 20 V 200 V 1000 V	100 µV 1 mV 10 mV 0.1 V 1 V	±(0.6% reading + 3 digits)	±(1.0% reading + 5 digits)	±(2.0% reading + 9 digits)

TECH 330		ACCURACY (1 YEAR, 20°C to 30°C)				
RANGE	RESOLUTION	45 Hz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz	10 kHz to 20 kHz	20 kHz to 40 kHz
200 mV	100 µV	± (0.6% reading + 4 digits)	± (1.0% reading + 5 digits)	± (1.5% reading + 6 digits)	± (2% reading + 7 digits)	± (5% reading + 16 digits)
2 V	1 mV					
20 V	10 mV					
200 V	0.1 V					Not Specified
1000 V	1 V					

EXTENDED FREQUENCY RESPONSE (TECH 330)
Typically ± 3 db at 100 kHz

CREST FACTOR (TECH 330 MODEL)
Allowable crest factor (peak/RMS ratio) varies from 1.0 to 5.0



CONVERSION TECHNIQUE
Averaging Models: Averaging sensing, calibration to display RMS value of sine wave
TECH 330 Model: True RMS responding (AC + DC)

INPUT IMPEDANCE (ALL RANGES)
2.2 megohms, shunted by less than 75 pF

RESPONSE TIME
Less than two seconds (on TECH 330 Model, above 10% of fullscale)

OVERVOLTAGE PROTECTION
Averaging Models: 1000 VRMS AC (1500 V peak) or 250 VDC (five seconds maximum above 450 VRMS on 200 mV range)
TECH 330 Model: 1000 VRMS AC (1500 V peak) or 1500 VDC (200 mV range, 500 VRMS or DC maximum)

2.4 DC CURRENT

The following specifications apply to the Series 300 Models, unless otherwise indicated.

TECH 300		ACCURACY (1 YEAR, 20°C to 30°C)
RANGE	RESOLUTION	
± 200 µA ± 2 mA ± 20 mA ± 200 mA ± 2 A	100 nA 1 µA 10 µA 100 µA 1 mA	± (1.0% reading + 1 digit)

		ACCURACY (1 YEAR, 20°C to 30°C)	
RANGE	RESOLUTION	TECH 310, TECH 310 UL	TECH 320B TECH 330
± 200 µA ± 2 mA ± 20 mA ± 200 mA ± 2 A	100 nA 1 µA 10 µA 100 µA 1 mA	± (0.75% reading + 1 digit)	± (0.35% reading + 1 digit)
± 10 A*	10 mA	± (1.5% reading + 1 digit)	± (1.0% reading + 1 digit)

*Continuous measurements up to ten amperes, thirty seconds maximum from ten to 19.99 amperes.

GENERAL
Automatic polarity indication (+ and – indicated)

RESPONSE TIME
Less than one second

VOLTAGE BURDEN
200 µA to 200 mA ranges: 250 mV maximum at fullscale
2 A and 10 A ranges: 700 mV maximum at fullscale

OVERCURRENT PROTECTION—A INPUT
Two amperes, 600 V (fused)

OVERCURRENT PROTECTION—10A INPUT
Up to twenty amperes for thirty seconds (unfused)
(Not applicable TECH 300 Model)

2.5 AC CURRENT

The following specifications apply to the Series 300 Models, unless otherwise indicated.

		ACCURACY (1 YEAR 20°C to 30°C)				
		45 Hz to 400 Hz		400 Hz to 2 kHz		2 kHz to 5 kHz
RANGE	RESOLUTION	TECH 310, TECH 310 UL, TECH 320B	TECH 330	TECH 310, TECH 310 UL	TECH 320B TECH 330	TECH 330
200 µA 2 mA 20 mA 200 mA 2 A	100 nA 1 µA 10 µA 100 µA 1 mA	±(1.5% reading + 3 digits)	±(0.9% reading + 3 digits)	±(1.6% reading + 3 digits)	±(0.9% reading + 3 digits)	±(1.5% reading + 3 digits)
10 A	10 mA	±(2.0% reading + 3 digits)	±(1.5% reading + 3 digits)			

	TECH 300	ACCURACY (1 YEAR, 20°C to 30°C)	
RANGE	RESOLUTION	45 Hz to 400 Hz	400 Hz to 2 kHz
200µA 2 mA 20 200 m 2 A	100 nA 1 µA 10 µ 100 µA 1 mA	±(2.0% reading + 4 digits)	±(2.0% reading + 4 digits

CREST FACTOR (TECH 330 Model)
1.0 to 5.0 (Refer to figure on Page 7.)

CONVERSION TECHNIQUE
Averaging Models: Average sensing, calibrated to display RMS value of sine wave
TECH 330 Model: True RMS responding (AC + DC)

RESPONSE TIME
Less than two seconds (on TECH 330 Model, above 10% of fullscale)

VOLTAGE BURDEN
200 µA to 200 mA ranges: 250 mV maximum at fullscale
2 A to 10 A ranges: 700 mV maximum at fullscale

OVERCURRENT PROTECTION—A INPUT
Two amperes, 600 V (fused)

OVERCURRENT PROTECTION—10A INPUT
Up to twenty amperes for thirty seconds (unfused)
(Not applicable TECH 300 Model)

2.6 RESISTANCE

The following specifications apply to the Series 300 Models, unless otherwise indicated.

RANGE	RESOLUTION	MAX TEST CURRENT	ACCURACY (20°C to 30°) TECH 300	TECH 310, TECH 310 UL	TECH 320B TECH 330
200Ω	0.1Ω	2.5 mA	±(0.75% reading +1 digit)	±(0.5% reading +1 digit)	±(0.2% reading +1 digit)
2KΩ	1Ω	250μA			
20kΩ	10Ω	25μA			
200kΩ	100Ω	2.5μA			
2MΩ	1000Ω	250nA			
20MΩ	10kΩ	25nA	±(1.5% reading +1 digit)		±(1.0% reading +1 digit)

GENERAL
Low-power ohms on all ranges

MAXIMUM OPEN CIRCUIT VOLTAGE
0.5 V, all ranges

MAXIMUM IN-RANGE VOLTAGE (Low-Power Ohms)
250 mV, all ranges

RESPONSE TIME
Less than one second, except on 20 MΩ range, less than four seconds

OVERLOAD PROTECTION
500 VDC or RMS AC, any range

2.7 DIODE TEST

The following specifications apply to the Series 300 Models, unless otherwise indicated.

RANGE
0 V to 2 V

RESOLUTION
1 mV

ACCURACY

TECH 300: ±(0.5% reading plus two digits)
TECH 310, 310 UL: ±(0.25% reading plus two digits)
TECH 330, 320B: ±(0.1% reading plus two digits)

ACCURACY CONDITIONS
One year, 20°C to 30°C

TEST CURRENT
2 mA, ±10%

RESPONSE TIME
Less than one second

OVERLOAD PROTECTION
500 VDC or RMS AC

2.8 INSTA-OHMS QUICK CONTINUITY INDICATOR (Except TECH 300 Model)

RESPONSE TIME
Less than 100 milliseconds
(TECH 320B Model Only): Insta-Ohms Continuity Indicator initiates a single audible tone burst of approximately 3500 Hz concurrent with the Insta-Ohms display

This section contains paragraphs that describe the following: unpacking and inspection, installation, controls, indicators, connectors, and initial checkout procedure.

3.1 UNPACKING AND INSPECTION

Remove the multimeter from the shipping container. The box should contain the following items:

1. Multimeter
2. TL-242 Probe Set (one black, one red)
3. Operator's manual for the Series 300 Models
4. Nine-volt battery (installed)
5. Except TECH 320B Model, two fuses (one installed and one spare inside the case). TECH 320B Model has one fuse installed. To gain access to inside of multimeter, see Paragraph 6.2.3.

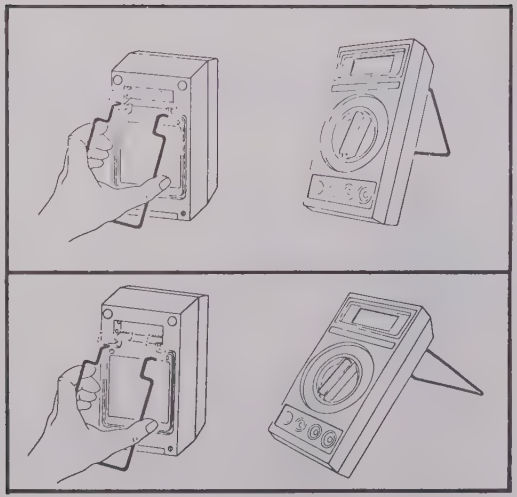
   Account for and inspect all of the above items. If any of the items are damaged or are missing, immediately return the complete package to the place of purchase for an exchange.

NOTICE

Retain the shipping container for use if the multimeter must be returned for exchange or repair.

3.2 INSTALLATION

The multimeter is shipped ready for use. The only action required by the user is to place the tilt bail in the desired position. Figure 1 shows the various positions that the tilt bail may be placed in. The tilt bail is moved from one position to another by squeezing the two sides of the bail together and then reinserting the tips in the desired position.



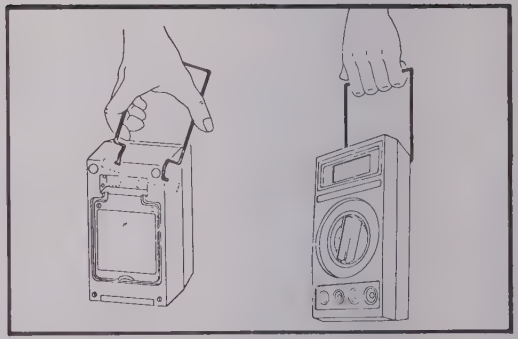


Figure 1. Positioning the Tilt Bail

3.3 MULTIMETER FAMILIARIZATION

This paragraph is designed to familiarize the user with the controls, indicators, connectors, and other features of the multimeter. It is HIGHLY RECOMMENDED that the user become familiar with the controls, indicators, and connectors shown and described in Figure 2 before operating the multimeter.

1. Digital Display
   A 3-½ digit display (maximum reading 1999) with automatic decimal point placement, automatic polarity indication, over-range indication, low battery indication (blinking decimal point), and on all but TECH 300 Model the Insta-Ohms Quick Continuity Indicator (Ω) indicates measured input value in volts, amperes, or ohms as selected by the Function/Range Switch.
2. Function/Range Switch
   This is the only control on the multimeter and greatly simplifies the operation. The one switch turns the multimeter off and on, selects the function, and selects the desired range. Six functions can be selected by directing the pointer on the center bar to: DCV, ACV, DCA, ACA, Ω (ohms), or Diode Test (⊣). The DCV function provides five ranges from 200 mV to 1500 volts DC except TECH 310 UL Model which has a maximum rating of 750 volts DC. The ACV function provides five ranges from 200 mV to 1000 volts RMS AC except TECH 310 UL Model which has a maximum rating of 500 volts RMS AC. The DCA and ACA functions each provide five ranges of current measurements from 200 μA to 2A fullscale. The 20m/10A positions in the DCA and ACA functions serve two purposes (except TECH 300 Model which has a maximum rating of two amperes). When using the "A" input jack, the 20m/10A position serves as the 20 mA range. When using the "10A" input jack the 20m/10A position, serves as the 10A range. The multimeter thus provides a total of six current ranges from both DC and AC current. The ohms function provides six ranges of resistance measurements from 200 ohms to twenty megaohms. The Insta-Ohms continuity test function (except the TECH 300 Model) operates in any resistance range.
3. Diode Test Function
   Diode test position is used for checking diodes and other semiconductor junctions.

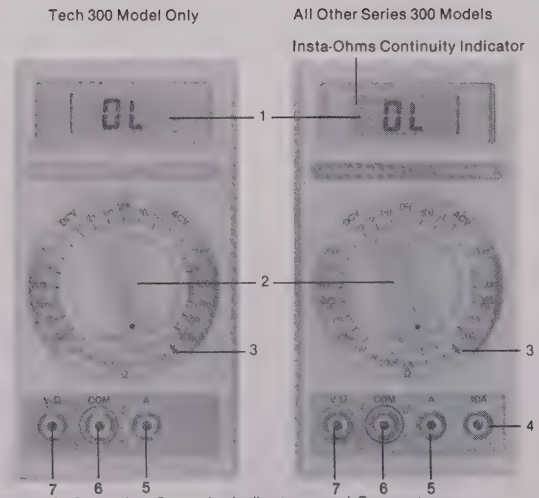


Figure 2. Operating Controls, Indicators, and Connectors

4. 10A Input Connector (Except TECH 300 Model)
   Banana jack connector used for continuous current measurements from zero to ten amperes. Measurements between ten and twenty amperes for a duration of thirty seconds maximum may also be made using this terminal. Inputs beyond this maximum may cause damage to the multimeter.
5. A Input Connector
   Banana jack connector used for current measurements up to two amperes. The multimeter is protected by a fuse against inputs over two amperes.
6. COM Input Connector (black)
   Banana jack connector used as the common or low input for all measurements.
7. V·Ω Input Connector
   Banana jack connector used as the high input for all voltage and resistance measurements.

3.4 INITIAL CHECKOUT

Before placing the multimeter into use, a simple checkout procedure will ensure that it is working properly. The only equipment required is the test leads.

1. Be certain that battery and fuse are installed properly, see Paragraphs 6.2.2 and 6.2.3.
2. Connect the red test lead to the V·Ω Input Connector and the black test lead to the COM Input Connector.
3. Place the Function/Range Switch in the maximum DCV position.
4. Touch the red test lead and black test lead together. Observe the Digital Display; it should read 000 ±1.
5. Turn the Function/Range Switch counterclockwise to each DCV position while observing the Digital Display. With the test lead tips in contact, the Digital Display should read zero plus or minus one digit and the decimal point positioned as follows:

200V	00.0
20V	0.00
2V	.000
200mV	00.0

6. Turn the Function/Range Switch to the 20 MΩ position. With the two test lead tips separated, the Digital Display should read OL (overrange).
7. Touch the test lead tips together and observe the Digital Display; it should read 0.00 or 0.01.
8. Turn the Function/Range Switch to each ohm position while observing the Digital Display. With the test lead tips in contact, the Digital Display should read zero in each position. In the 200Ω position, the Digital Display may read 000.1 or 000.2 because of test lead resistance. The decimal point should be positioned as follows:

20MΩ	0.00
2MΩ	.000
200kΩ	00.0
20kΩ	0.00
2kΩ	.000
200Ω	00.0

9. Turn the Function/Range Switch to the maximum ACV position

WARNING

The next step requires the measurement of the local AC line (mains) voltage. Be careful not to touch the test lead tips with fingers and do not allow the tips to contact each other.

10. Measure the local line (mains) voltage at a convenient AC power outlet. The Digital Display should show the appropriate voltage with a resolution of one volt.
11. Remove both probes from the AC outlet.
12. If the multimeter has performed properly during this checkout procedure, it is fully operational and ready to use.

NOTICE

When using the 10A Input Connector for current measurements, the test lead jack must be fully depressed into the input connector. This engages a microswitch which enables the ten-ampere current shunt.

This section of the manual describes the various operating modes of the multimeter as well as a summary of warnings and precautions.

4.1 WARNINGS AND PRECAUTIONS

The following warnings and precautions are intended to protect the user from injury and the multimeter from damage.

4.1.1 WARNINGS

1. The TL-242 Probe Set, supplied with multimeter, is designed specifically for use with the Series 300 Multimeters. Users should not attempt to measure voltages or currents that may exceed the ratings marked on the Function/Range Switch or terminal overlays.
2. Use extreme caution when working near high voltage sources. Ths includes any voltage measurements requiring the use of the two highest VAC or VDC ranges.
3. To avoid electrical shock hazard and/or damage to the multimeter, do not measure voltages that might exceed the maximum voltages rating above earth ground.
4. Operator injury or damage to the multimeter may occur during current measurements using the A Input Connector if the fuse blows in a circuit which exhibits an open-circuit voltage greater than 600 volts.
5. Before each use of the multimeter, inspect test leads, connectors, and probes for cracks, breaks, or crazes in the insulation. If any defects are found, replace item immediately.
6. To avoid electrical shock hazard, do not touch test leads, tips, or the circuit being tested while power is applied to the circuit being measured.

4.1.2 PRECAUTIONS

1. Exceeding the maximum input overload limits can damage the multimeter.
2. When making current measurements, make sure that the multimeter is connected in series with the load in which the current is to be measured. NEVER connect the multimeter ACROSS a voltage source. To do so, can result in either blowing the overload protection fuse or damaging the device being tested.

4.2 OVERLOAD INDICATION

The Series 300 Multimeters are equipped with automatic overload indication. This means that whenever an input signal is larger than the range selected, an OVERLOAD symbol (OL) will appear in the Digital Display, see Figure 6. This feature allows the user to test devices with unknown circuitry where an overload condition might exist but would not exceed the capability of the multimeter. See Section Five for a complete description of overload protection.

4.3 VOLTAGE MEASUREMENTS

4.3.1 DC VOLTAGE

1. Connect red test lead to V·Ω Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired DCV position. If the magnitude of voltage is not known, set switch to highest range and reduce setting until satisfactory reading is obtained.
3. Turn off power to device or circuit being tested and discharge all capacitors.

WARNING

To avoid electrical shock hazard and/or damage to the multimeter, do not attempt to measure voltages that might exceed the maximum voltage rating.

4. Connect test leads to device or circuit being measured.
5. Turn on power to device or circuit being measured. Voltage value will appear on Digital Display along with the voltage polarity.
6. Turn off power to device or circuit being tested and discharge all capacitors before disconnecting test leads from device or circuit being tested.

4.3.2 AC VOLTAGE

1. Connect red test lead to V·Ω Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired ACV position. If the magnitude of voltage is not known, set switch to highest range and reduce setting until satisfactory reading is obtained.
3. Turn off power to device or circuit being tested and discharge all capacitors.

WARNING

To avoid electrical shock hazard and/or damage to multimeter, do not attempt to measure voltage that might exceed the maximum voltage rating in VRMS or 1.5 times the maximum voltage rating in volts peak AC.

4. Connect test leads to device or circuit being measured.
5. Turn on power to device or circuit being measured. Voltage value will appear on Digital Display.
6. Turn off power to device or circuit being tested and discharge all capacitors before disconnecting test leads from device or circuit being tested.

4.3.3 TRUE RMS MEASUREMENTS (TECH 330 Model)

The TECH 330 Model permits the direct measurement of the total RMS (AC + DC) value of a signal. This is particularly useful in measuring the output of power-control circuits and switching power supplies. Occasionally, however, there may be need to know only the AC component, such as in measuring the ripple on a power supply output. This can be accomplished by placing a capacitor (0.047 μF to 0.22 μF) in series with the test leads to block the DC component of the signal. The capacitor should have a voltage rating exceeding the magnitude of the DC voltage to be blocked. Selection of an appropriate ACV range then gives a direct reading of the signal RMS AC component.

4.3.4 APPLICATION NOTE

Understanding the AC conversion process in the multimeter will help the user to more fully utilize its measurement capability.

The AC converter used in the averaging models is "average-responding." An RMS value is determined by first rectifying and filtering the signal to obtain the average value. The average value is then scaled upward by a factor of 1.11 to obtain the RMS value. The scaling factor of 1.11 is accurate in the measurement of sine wave signals for which the relationship between the average and RMS values is as follows:

$$VRMS = Vavg \frac{\pi}{2\sqrt{2}}$$

$$= 1.11\ Vavg$$

In measuring nonsinusoidal waveforms, however, significant errors can be introduced because of different scaling factors relating average to RMS values. Rough correction factors can be sometimes calculated for standard waveforms that are free from significant noise and distortion but accurate measurements of complex waveforms can be difficult to achieve.

RMS values of nonsinusoidal AC signals can be measured directly and more accurately with the TECH 330 Model which features a "true-RMS responding" AC converter. True-RMS AC response can be particularly useful in measuring complex or noisy signals for which even rough correction factors cannot be easily computed.

AC converters of all types are limited by their frequency response and input dynamic range. Bandwidth defines the range of frequencies in which the conversion accuracy is within three decibels. The bandwidth of the TECH 330 Model is 100 kHz. Measurements of complex signals will not be affected by converter bandwidth limitations unless there are significant harmonic components beyond 100 kHz.

Crest factor is a measure of the input dynamic range of a true-RMS responding AC converter. It expresses the capability of the AC converter to handle a signal that has large peak values compared to its RMS value without saturating the converter circuitry and degrading the specified accuracy.

For the TECH 330 Model, crest factor is defined as the ratio of the peak voltage to the total RMS (AC + DC) voltage.

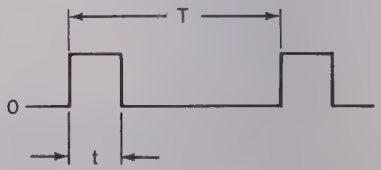
$$\text{Crest Factor} = \frac{\text{V peak}}{\text{VRMS}}$$

Crest factor for a pulse train is also related to duty cycle (D) as follows:

$$\text{Crest Factor} = \sqrt{\frac{1}{D}}$$

where

$$D = \frac{t}{T}$$



Crest factor for the TECH 330 Model ranges from 1.0 to 5.0 on each voltage scale depending on the RMS value of the signal being measured. At fullscale (1999 counts), signals with crest factor between 1.0 and 1.5 can be measured. Signals with crest factor of 1.0 include a square wave or pure DC (peak voltage equals RMS voltage). An undistorted sine wave signal (crest factor = 1.414) can also be measured at fullscale. Even a sine wave with considerable harmonic distortion can still be accurately measured at fullscale.

At half scale (1000 counts), signals with crest factor between 1.0 and 3.0 can be measured without performance degradation. At 600 counts and below, signals with crest factors up to 5.0 can be measured. If the crest factor of a waveform is not known, it can be determined by measuring the peak voltage with an oscilloscope and dividing by the RMS voltage measured by the multimeter. The crest factor of some typical waveforms is shown in Figure 3.

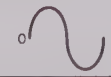
Waveform	Crest Factor
Sine Wave 	1.414
Sawtooth	1.732
Half-Wave Rectified Sine Wave	2.0
SCR Output 100% to 10%	1.414 to 3.0
Rectangular Pulse 50% > D > 10%	1.414 to 3.16

Figure 3. Typical Waveform Crest Factors

4.4 CURRENT MEASUREMENTS

4.4.1 DC CURRENT

1. Connect red test lead to the A Input Connector for current measurements up to two amperes. For current measurements between two and ten amperes, using models with ten ampere capability, connect red test lead to the 10A Input Connector. Connect black test lead to COM Input Connector.

NOTE

When using the 10A Input Connector for current measurements, the test lead jack must be fully depressed into the input connector.

2. Set Function/Range Switch to desired DCA position. If the magnitude of current is not known, set switch to highest range and reduce setting until satisfactory reading is obtained. When the 10A Input Connector is used, the Function/Range Switch should be placed in the 20m/10A position.
3. Turn off power to device or circuit being tested and discharge all capacitors.
4. Open circuit in which current is to be measured. Securely connect test leads in series with the load in which current is to be measured.
5. Turn on power to circuit being tested.
6. Read current value on Digital Display.
7. Turn off all power to circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

4.4.2 AC CURRENT

1. Connect red test lead to A Input Connector for measurements up to two amperes. For current measurements between two and ten amperes, using models with ten ampere capability, connect red test lead to 10A Input Connector. Connect black test lead to COM Input Connector.

NOTE

When using the 10A Input Connector for current measurements, the test lead jack must be fully depressed into the input connector.

2. Set Function/Range Switch to desired ACA position. If the magnitude of current is not known, set switch to highest range and reduce setting until satisfactory reading is obtained. When the 10A Input Connector is used, the Function/Range Switch should be placed in the 20m/10A position.
3. Turn off power to device or circuit being tested and discharge all capacitors.
4. Open circuit in which current is to be measured. Securely connect test leads in series with the load in which the current is to be measured.
5. Turn on power to circuit being tested.
6. Read current value on Digital Display.
7. Turn off all power to circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

4.5 RESISTANCE MEASUREMENTS

All resistance ranges on the multimeter are low-power ohms which allow accurate measurements of in-circuit resistance. (Use Diode Test Function for checking diode and other semiconductor functions.)

1. Connect red test lead to V·Ω Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired ohm position. If the magnitude of resistance is not known, set switch to highest range and reduce setting until satisfactory reading is obtained.
3. If the resistance being measured is connected to a circuit, turn off power to circuit being tested and discharge all capacitors.
4. Connect test leads to circuit being measured. When measuring high resistance be careful not to contact adjacent points, even if insulated. Some insulators have a relatively low insulation resistance, which can cause the measured resistance to be lower than the presumed resistance.
5. Read resistance value on Digital Display. If a high resistance value is shunted by a large value of capacitance, allow the Digital Display to stabilize.

4.6 DIODE AND TRANSISTOR TEST MEASUREMENTS

The special Diode Test Function allows accurate measurements of forward voltage drops across diodes and transistor junctions. A constant-current source forces two milliamperes of current into the semiconductor junction under test, which results in the voltage drop being displayed on the Digital Display. This function also permits measurement of in-circuit semiconductor junctions with as little as 500 ohms in parallel with the transistor or diode. The limited current produced by the multimeter in the Diode Test Function minimizes the possibility of damage to low-power semiconductor junctions; a common problem with many analog meters.

4.6.1 DIODE TESTS

To perform diode test measurements, use the following procedure:

1. Connect red test lead to V·Ω Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to the Diode Test (⊣◀) position.
3. If the semiconductor junction being measured is connected to a circuit, turn off power to circuit being tested and discharge all capacitors.
4. Connect test leads to device.
5. Read forward voltage drop on Digital Display. If the Digital Display reads OL, reverse the lead connections. The placement of the leads when the forward voltage is displayed (normally 600 to 900 mV) indicates the orientation of the diode. The red lead is then connected to the anode and the black lead is connected to the cathode, as shown in Figure 4.

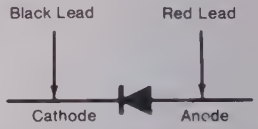


Figure 4. Placement of Leads in Respect to Anode and Cathode

If OL is displayed with both lead connections, the junction is open.

If a low reading (less than one volt) is obtained with both lead connections, the junction is shorted internally or (if the junction is measured in a circuit) the junction is shunted by a resistance less than 200 ohms. In the latter case, the junction must be disconnected from the circuit in order to verify its operation.

4.6.2 TRANSISTOR JUNCTION TESTS

Transistors can be tested in the same manner as diodes by checking the two diode junctions formed between the base and emitter and the base and collector of the transistor. Figure 5 shows the orientation of these effective diode junctions for PNP and NPN transistors.

To complete the transistor tests, check for shorts between the collector and emitter.

4.6.3 TRANSISTOR BETA TEST

With a simple test fixture, provided by the user, the Diode Test Function can be used to determine the DC current gain (beta) of a transistor. Beta is measured using DC collector-to-emitter voltage (V_{CE}) of about one volt and a collector current (I_C) of about two milliamperes.

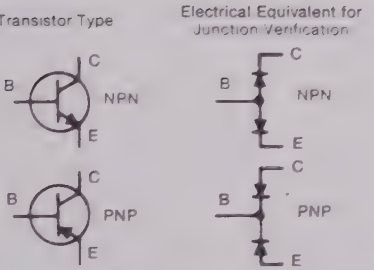


Figure 5 Orientation of Effective Diode Junctions for PNP and NPN Transistors

A transistor beta test setup is shown in Figure 6 for an NPN transistor. For PNP transistors, the connections to the multimeter should be reversed. To determine transistor beta, use the following procedure:

1. With all the connections made as shown in Figure 6, and with switch S1 open, record the displayed reading (ignore decimal point).

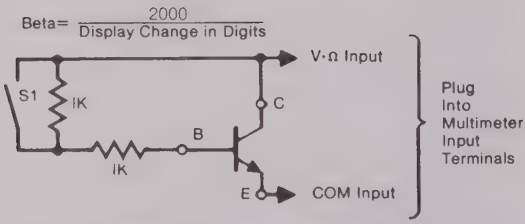


Figure 6. Test Fixture for Transistor Beta Measurement

NOTICE

If an overload indication is obtained, reverse the connections to the multimeter.

If an overload indication is obtained regardless of meter orientation, or if a reading less than 0.200 is obtained, the transistor is probably defective.

2. Close switch S1 and record the new displayed reading (ignore decimal point).
3. Divide 2000 by the difference in digits between the readings obtained in Steps 1 and 2 immediately preceding. The resulting number is the DC beta of the transistor.

4.7 CONTINUITY AND CAPACITOR CHECKS

Before the Beckman Digital Multimeter, quick continuity checks using a digital volt/ohm meter were not possible. Now they can be done just as quickly and as easily as with an analog meter. This feature is particularly useful in circuit and cable tracing, but also may be used for troubleshooting small-value capacitors.

4.7.1 CONTINUITY CHECKS

1. Place Function/Range Switch in any ohm range.
2. Connect red test lead to the V·Ω Input Connector. Connect the black test lead to the COM Input Connector. With the test leads separated or measuring an out-of-range resistance, the Digital Display will indicate OL (overload), Figure 7.
3. Place one test lead probe at one end of cable or circuit to be tested. Use the other test lead to trace the circuit or cable until the circuit is complete. When continuity is established, an ohm symbol will appear in the upper left-hand corner of the Digital Display, Figure 8. If contact in

the cable or circuit is maintained long enough (about one-quarter of a second), the OL will disappear and the resistance value of the cable or circuit will appear next to the ohm symbol, Figure 9.

NOTICE

The Insta-Ohms Quick Continuity Indicator quickly identifies completed circuit paths. The trigger point is approximately two to five times the maximum resistance measurable on the selected range.

Figure 7. Display of Overload Symbol

Figure 8. Display of Insta-Ohms Quick Continuity Indicator (Ω)

Figure 9. Display of Insta-Ohms Quick Continuity Indicator and Resistance Value

4.7.2 CAPACITOR CHECKS

The Insta-Ohms Quick Continuity Indicator (except TECH 300 Mode) also can be used as a rough check of capacitors with a value of greater than or equal to 0.01 μF. This feature can be a great aid in troubleshooting circuits in which an open or shorted bypass capacitor is suspected. Use the following procedure to check capacitors.

1. Place Function/Range Switch in 20 MΩ range position.
2. Connect red test lead to VΩ Input Connector. Connect the black test lead to the COM Input Connector. With the test leads separated the Digital Display will indicate OL (overload), Figure 7.
3. Discharge the capacitor to be checked by briefly shorting the capacitor ends.
4. Place red test lead probe at one end of capacitor. Place the black test lead at other end of capacitor.

NOTICE

Do not touch capacitor leads or test probe ends during capacitor check because proper operation of Insta-Ohms feature could be affected.

5. If the Insta-Ohms symbol (Ω) appears briefly and then disappears, the capacitor is accepting a charge.

FOR MYLAR CAPACITORS

If the Insta-Ohms symbol does not appear, reverse the test leads. If the Insta-Ohms symbol still does not appear, probably the capacitor is open. If the capacitor is shorted, a low resistance value will be displayed.

FOR ELECTROLYTIC AND TANTALUM CAPACITORS

A good capacitor will show a reading. A display of OL indicates an open capacitor. A display of 0.00 indicates a shorted capacitor.

NOTICE

Insta-Ohms can only be used to check capacitors with a value of 0.01 μF or greater.

4.8 DECIBEL MEASUREMENTS

In addition to its normal functions, the multimeter can be used to measure decibels. The value obtained from this measurement can be used to indicate the gain and accuracy of electronic devices. The decibel (dB) is the logarithm of the ratio of two electrical signals; usually a certain amount of power across a fixed resistance is used as a reference and denoted as 0 (zero) decibels. In Figure 10, zero decibel is defined as one milliwatt into 600 ohms. Use the procedure of Paragraph 4.3.2 to determine AC voltage and the graph of Figure 10 to determine decible value.

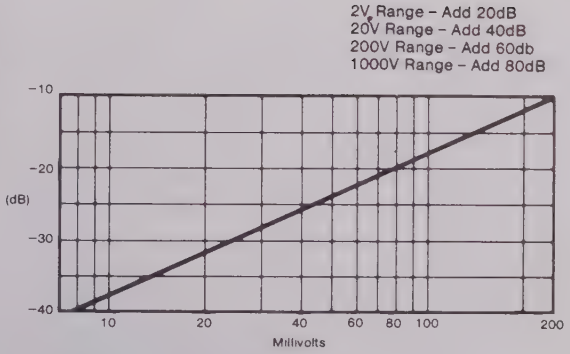


Figure 10. Decibel Conversion Chart

5.1 GENERAL

The central part of a Beckman Digital Multimeter is the custom-designed CMOS LSI multiprocessor chip. To increase reliability of the multimeter, much of the necessary electronic circuitry is incorporated on the multiprocessor chip. The chip contains an active input filter, an averaging AC-to-DC converter, the Insta-Ohms detection and resistance measurement circuitry, an analog-to-digital converter with ±200 mVDC fullscale ratiometric inputs, and all necessary digital and LCD display drive circuitry.

Peripheral components are used with this chip to perform a range of voltage, current, resistance, and semiconductor measurements, and to provide overall multimeter protection.

Included in the peripheral circuits are the Function/Range Switch, three resistor networks, a voltage reference diode, several circuit protection components, the battery, and the display. The TECH 330 model also contains an additional LSI chip which performs true-RMS conversion of the AC signals.

5.2 OVERALL FUNCTIONAL DESCRIPTION

Simplified block diagrams are shown in Figure 11 and Figure 12. Schematic wiring diagrams are shown in Figure 13 and Figure 14.

The Function/Range Switch routes the input signal to an appropriate input conditioning circuit which converts the input signal to a DC voltage between −200 mV and +200 mV. This signal can then be processed by the multiprocessor chip. After the signal has passed through an active filter for normal-mode rejection of interfering powerline and audio frequency signals, the on-chip analog-to-digital converter digitizes the signal into display segment driving signals, resulting in an accurate digital display of the applied input signal.

Decimal point positions on the display are determined automatically by the multiprocessor chip, based upon the Function/Range Switch settings.

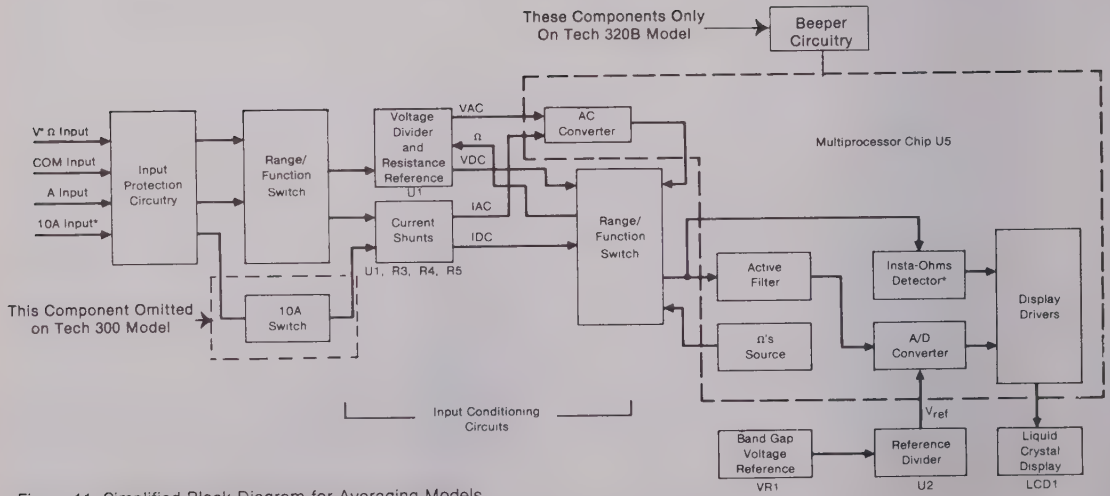


Figure 11. Simplified Block Diagram for Averaging Models

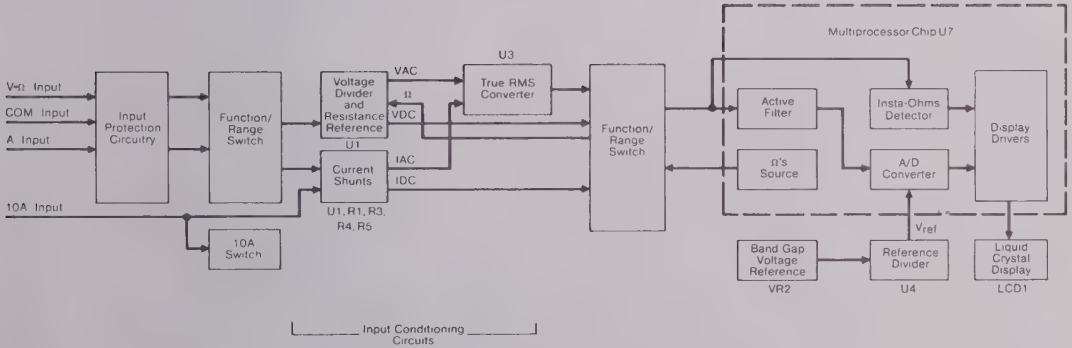


Figure 12. Simplified Block Diagram TECH 330 Model

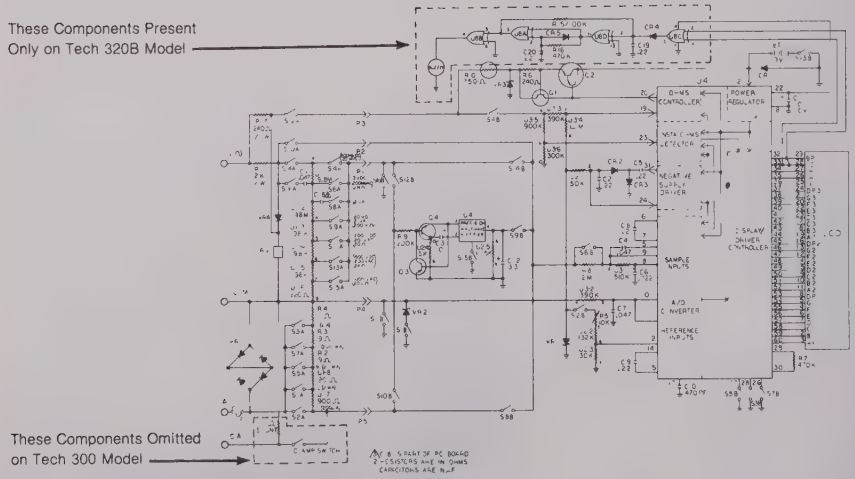


Figure 13. Schematic Wiring Diagram of Averaging Models

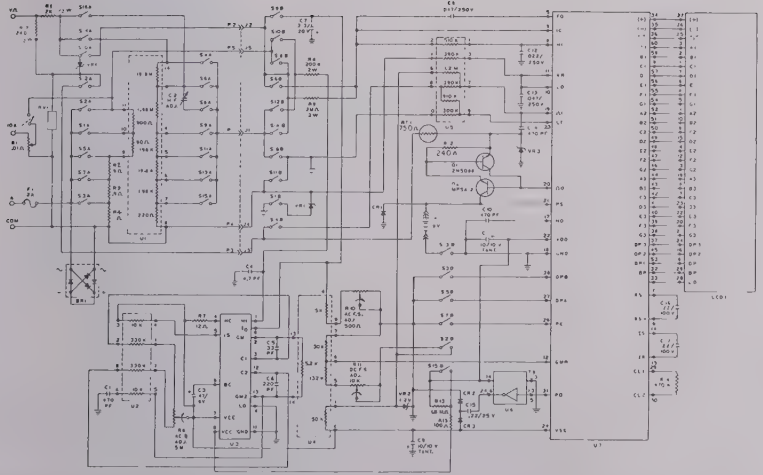


Figure 14. Schematic Wiring Diagram of TECH 330 Model

5.3 BLOCK DIAGRAM ANALYSIS

5.3.1 INPUT PROTECTION CIRCUITRY

Input protection circuitry has been provided to protect the multimeter from normally encountered overloads and range selection errors.

In the DC voltage ranges, primary over-voltage protection is provided by a two megohm series resistor working into voltage limiters included in the converter chip. Continuous overloads of 1500 VDC and an energy-limited transients of much higher voltage can be accepted. Secondary protection from high transient voltages is provided by a metal-oxide-varistor. On all resistance ranges and the diode test function, a positive temperature coefficient resistor and zener diodes provide isolation from the application of external voltages.

In the current mode, protection is provided by a combination of a diode limiter bridge and a two-ampere 600-volt fuse. The fuse will blow for long-term overloads and the diodes divert overloads from the current measurement resistors.

Although not fuse-protected, the ten ampere current input connects directly into a durable ten megohm current shunt that can withstand ten amperes continuously and up to twenty amperes for a short duration (less than fifteen seconds).

5.3.2 INPUT CONDITIONING CIRCUITS

The analog-to-digital converter on the multiprocessor chip accurately converts an unknown voltage within the range of −200 mV to +200 mVDC to a digital equivalent which is displayed on the Digital Display. If the signal being measured is other than a DC voltage in the ±0.2 V range, the signal must be converted to a DC voltage and scaled down before being presented to the analog-to-digital converter. This is the function of the input conditioning circuits.

Voltage Measurements

A precision-ratio resistor network is used on the voltage divider for both AC and DC voltage ranges. The voltage divider is part of a Beckman thin-film resistor network. Thin-film resistor networks exhibit exceptionally good long-term stability and contribute significantly to the long-term accuracy of Beckman Multimeters.

If the ±200 MVDC range is selected, the input signal feeds directly into the multiprocessor chip. On all other higher DC voltage ranges, a precise power-of-ten voltage is selected from the voltage divider as the multiprocessor input. If an ACV range is selected, voltage divider output is

coupled to an AC converter which, in turn, provides a proportional output to the active filter input to the multiprocessor chip.

On averaging models the AC converter is an *averaging* converter, a precision half-wave rectifier where the output is a DC voltage calibrated to equal the RMS value of a sine wave input. The AC converter is located on the multiprocessor chip and is separately powered to save battery drain except during AC voltage and AC current measurements.

On the TECH 330 Model, the AC conversion process is accomplished in the true-RMS converter chips. The TECH 330 Model calculates the RMS value of an input voltage by performing the electronic equivalent of the actual mathematical function:

$$Vrms = \sqrt{\frac{1}{T}\int_{0}^{T} V_{IN}^{2}(t)dt}$$

A block diagram of the true-RMS converter chip is shown in Figure 15.

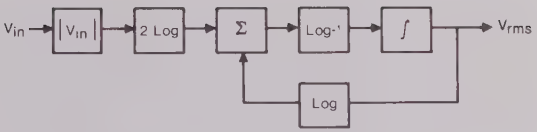


Figure 15. True-RMS Converter Block Diagram

Resistance Measurements

Resistance measurements are made using a ratio technique where the unknown resistance is compared against an internal standard. As shown in Figure 16, the unknown resistance is connected in series with a selected reference resistor to a bias voltage generated by the multiprocessor chip.

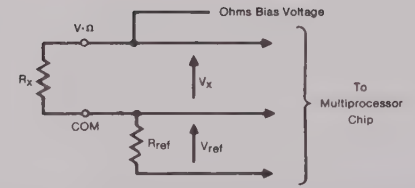


Figure 16. Input Conditioning Circuit for Resistance Measurements

The reference resistor is selected to be equal to the fullscale range of the unknown resistor being measured. For example, if the twenty kilohm range is selected, a precision twenty kilohm resistor is switched across the reference input. Reference resistors are selected from the same thin film resistor network used as the voltage divider for voltage measurements. Because of negligible loading at the sensing terminals by the multiprocessor chip, the ratio of the two resistors is equal to the ratio of their respective voltage drops.

$$\frac{V_x}{R_x} = \frac{V_{ref}}{R_{ref}}$$

The analog-to-digital converter on the multiprocessor chip uses a ratiometric conversion technique which relies solely on the ratio of the unknown voltage, V_x, to a reference voltage, V_{ref}. Choosing a low bias voltage assures that the voltage developed across the unknown resistance is 0.25 volt maximum. This allows low voltage testing of resistors in circuits where the presence of semiconductor junctions could otherwise affect the measurement accuracy.

Current Measurements

Current is converted to a DC voltage by passing the current through a selected shunt resistor, resulting in a voltage drop (I·R) within the ±200 mV range required by the multiprocessor chip. This process assures that the maximum voltage burden or voltage dropped through the current sense resistor is less than 0.25 volt.

The resistors that are switched in series to make current shunt values from 0.1 ohm to 1000 ohms are part of the thin-film network and wirewound resistors.

The voltage drop from a DC current measurement is routed directly to the multiprocessor chip. In AC current ranges, the shunt voltage drop is routed to the same AC converter used in the conversion of AC voltages.

Diode Measurements
The diode test operating mode provides a repeatable and easily understandable means to check semiconductor junctions. In this mode, the multimeter operates with a one volt fullscale (± one volt) DC measurement range. A two milliampere constant test current is supplied via the V·Ω terminal. The resulting junction forward voltage drop is scaled to within ±200 mV by the voltage divider, converted in the multiprocessor chip, and presented on the Digital Display. Reverse connections (checking diode blocking) will normally read OL on the Digital Display.

5.3.3 MULTIPROCESSOR CHIP

The multiprocessor chip contains the averaging AC converter, an active input filter, the Insta-Ohms detector, the analog-to-digital converter, circuits for controlling the voltage polarity signs, the overload indicator and the low battery indicator, and all display drivers.

Active Filter
A second-order Bessel filter is incorporated in the multiprocessor chip to insure broadband normal-mode rejection of interfering powerline and audio frequencies. This features combined with the usual six decibel per octave rejection of the integrating converter, provides more than 60 decibel rejection at powerline frequencies.

Insta-Ohms Quick Continuity Indicator
The Insta-Ohms Quick Continuity Indicator (except TECH 300 Model) allows a very quick determination of circuit continuity. The Insta-Ohms detector consists of a single-bit, analog-to-digital converter that triggers at approximately twice fullscale input in any ohms range. Because it is separate from the main analog-to-digital conversion circuitry, normal conversion time is not required and indication in the Digital Display occurs almost immediately (within 0.1 second).

On the TECH 320B Model, the Insta-Ohms Continuity Indicator initiates a single audible tone burst of approximately 3500 Hz concurrent with the Insta-Ohms display.

Analog-to-Digital Converter

The analog-to-digital converter performs a true ratio voltage conversion between two input ports. One input to the converter is the unknown input voltage. For all voltage and current measurements, the reference or second port is connected to a precision voltage reference generated by a band gap diode and a voltage divider network. The reference voltage is set by an adjustment of a trimmer. In the averaging models, this one trimmer comprises the only adjustment required for calibration.

When the unknown input voltage exactly equals the reference voltage, a fullscale reading results from the analog-to-digital converter. As the ratio of the unknown input voltage to the reference voltage declines, proportionally lower readings result from the main converter.

In the resistance ranges, the reference input is supplied by the voltage drop across a reference resistor connected in series with the unknown resistance.

This section of the manual describes maintenance procedures, calibration, and troubleshooting. In addition, a general statement on service policy is included. Any questions regarding warranty repair or instrument servicing should be directed to Beckman Instruments, Inc., at (714) 993-8852.

6.1 WARRANTY STATEMENT

The warranty statement for the Beckman Multimeters appears on the inside front cover of this manual. Read it carefully before requesting warranty repairs.

6.1.1 WARRANTY REPLACEMENT

Any Series 300 Multimeter claimed to be defective should be returned to Beckman Instruments, Inc., with a $3.00 handling fee from within the Continental U.S.A.; $12.00 from elsewhere.* Follow the shipping instructions of Paragraph 6.1.3.

Warranty replacement will be made typically within two working days after receipt of defective unit.

*Prices subject to change without notice.

6.1.2 NON-WARRANTY REPAIRS

Any out-of-warranty multimeter that is defective, but repairable, can be returned to Beckman Instruments, Inc., for an estimate of the cost of repair. After subsequent receipt of a purchase order or cash for the estimated cost of repair, non-warranty repairs are typically made in two days. All non-warranty repairs carry a three (3) month warranty. Contact any authorized Beckman Service Center or Beckman Instruments, Inc., for the current non-warranty rates.

6.1.3 SHIPPING INSTRUCTIONS

A multimeter returned for calibration or repair should be shipped with the following information or items: company name, customer's name, address, telephone number, proof of purchase (warranty repairs), a description of the problem encountered or service required, and the appropriate service charge.

Service charges should be remitted in either the form of a check, money order, or purchase order made payable to Beckman Instruments, Inc.

A multimeter should be shipped with transportation charges prepaid to the following address:

Beckman Instruments, Inc.
210 S. Ranger
Brea, CA 92621
Attn: Customer Service

A multimeter will be returned to the customer with transportation charges paid by Beckman Instruments, Inc.

6.2 MAINTENANCE PROCEDURES

Regular operator maintenance of the multimeter consists of: cleaning case and window, battery replacement, and fuse replacement. All other repairs should be performed by the Beckman Service Center or other qualified instrument service personnel.

6.2.1 CLEANING CASE AND WINDOW

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These chemicals will react with plastics used in construction of the case.

The front panel case should be cleaned with a mild solution of detergent and water. Apply sparingly with a soft cloth and allow to dry completely before using.

6.2.2 BATTERY REPLACEMENT

WARNING

To prevent electrical shock hazard, turn off the multimeter and disconnect test leads before removing the back cover.

1. After disconnecting test leads and turning off the multimeter, remove back cover by removing the four screws, Figure 16; then lift off the back cover.

CAUTION

Failure to turn off the multimeter before installing the battery could result in damage to the battery if it is connected to the battery terminal incorrectly.

2. The battery is located in the front part of the case as shown in Figure 17. Disconnect battery from multimeter terminal and replace with a standard nine-volt transistor battery.

3. Replace the back cover and secure with the four screws.

WARNING
Do not operate multimeter with back cover removed (except during calibration).

6.2.3 FUSE REPLACEMENT

WARNING
To prevent electrical shock hazard, turn off the multimeter and disconnect test leads before removing the back cover.

1. After disconnecting test leads and turning off the multimeter, remove back cover by removing the four screws Figure 17, then lift off the cover.
2. The fuse is located in the upper half of the multimeter, Figure 17 or Figure 18. Remove old fuse and replace with spare fuse.

WARNING
To prevent fire, use 2A/600V fuse.

3. Replace the back cover and secure with the four screws.

WARNING
Do not operate multimeter with back cover removed (except during calibration).

6.3 CALIBRATION

In order to maintain the specifications described in Section Two of this manual, it is recommended that the multimeter be calibrated once each year and/or after it is repaired.

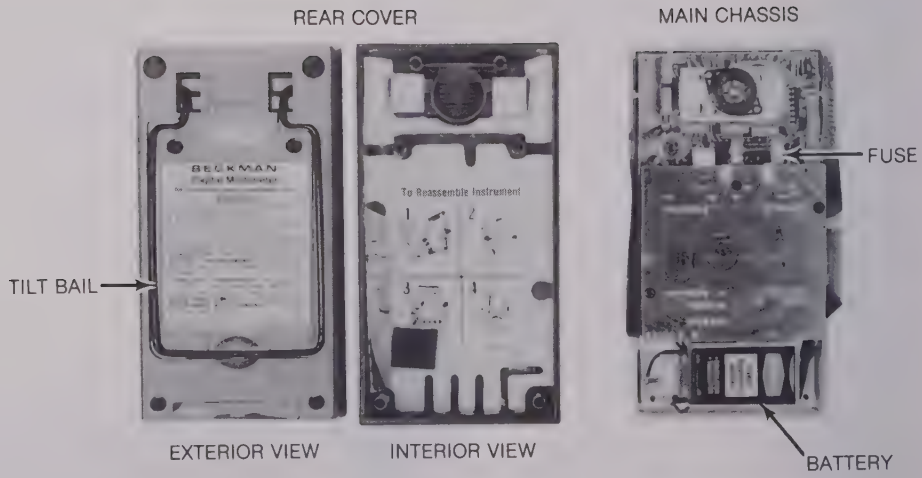


Figure 17. Views of TECH 320B Model

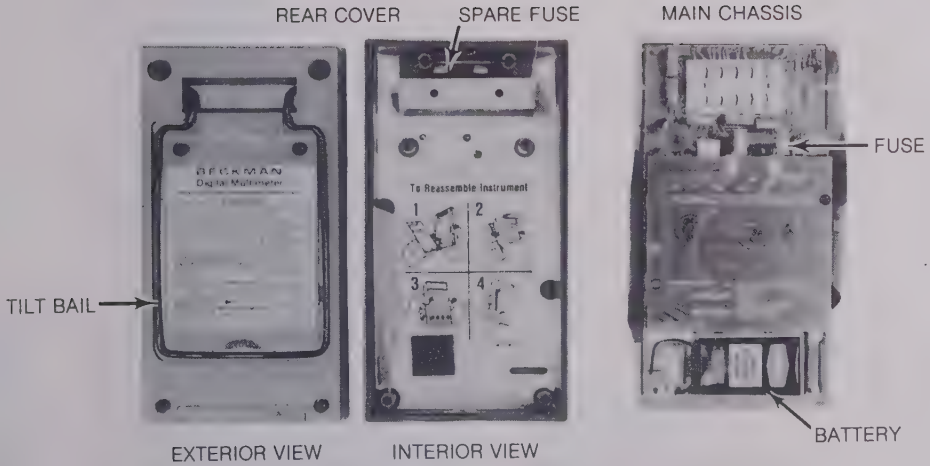


Figure 18. Views of Non-Beeper Models

The equipment required for calibration is listed in Figure 19.

Instrument Type	Required Characteristics	Recommended Models
DC calibrator	Voltage Range: 0 to 1000 VDC Accuracy: ±0.025%	Rotek 600 or Equivalent
AC calibrator (For use with TECH 330 Model only)	Voltage Range: 0 to 110 VAC Frequency Range: 400 Hz to 20 kHz Voltage Accuracy: 0.05% at 400 Hz; 0.5% at 20 kHz.	Rotek 600, HP 745A, or Equivalent

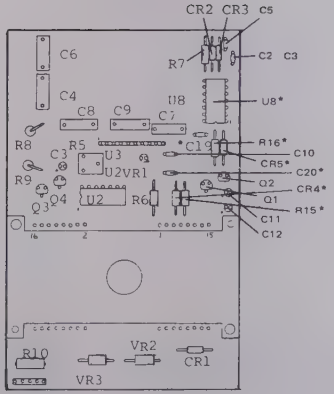
Figure 19. Equipment Required for Calibration

6.3.1 CALIBRATION OF AVERAGING MODELS

1. Perform calibration at an ambient temperature of 25 ± 2°C and a relative humidity of 80% or less. Allow multimeter to stabilize at this temperature for at least thirty minutes.
2. Remove the back cover from the multimeter by removing the four screws and then lifting off cover.
3. Set the output of the DC calibrator for 190 mV ±0.02% and connect it to the V·Ω and COM Input Connectors.
4. Turn the Function/Range Switch on the multimeter to the 200 mV DCV position.
5. Using a small flat-tipped screwdriver, adjust potentiometer R6 as identified in Figure 20, until Digital Display reads +190.0 or +190.1.
6. Disconnect the DC calibrator from the multimeter.
7. Replace the back cover and secure with the four screws.

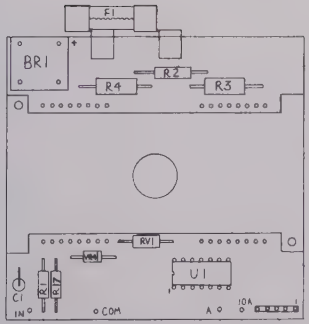
6.3.2 CALIBRATION OF TECH 330 MODEL

1. Use the procedure of Paragraph 6.3.1 through Step 6, and then proceed as follows.
2. Short the input terminals.
3. Turn Function/Range Switch on multimeter to the 1000V ACV position.
4. Adjust potentiometer R6 as identified in Figure 20, until the Digital Display reads 000 or 001. Make this adjustment very slowly to allow the multimeter to stabilize.
5. Turn Function/Range Switch on multimeter to the 200 mV ACV position.
6. Set the output of the DC calibrator to 190 mV. Connect the DC calibrator to the V·Ω and COM (polarity is not important) Input Connectors.



Main Board

*Model TECH 320B Only



Piggyback Board
(Inside View)

NOTE
R1 is Located Under
the Battery Cradle

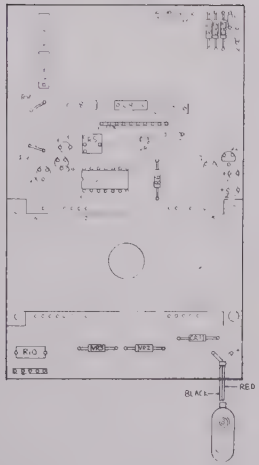


Figure 20. Components Locator for Averaging Models

7. Adjust potentiometer R6, as identified in Figure 20, until the Digital Display reads 190.0 ±1 digit.
8. Disconnect the DC calibrator.

NOTICE

The following procedure describes the high frequency adjustment of the true-RMS converter. At 20 kHz, the calibration frequency, the two VAC multimeter readings will tend to be higher with the back cover shield removed than with the cover attached. It is necessary, therefore, to adjust the multimeter to read higher than the calibration standard voltage so that with the cover attached, the desired output is achieved.

9. Place Function/Range Switch on multimeter in the 2V ACV position and set the AC calibrator for an output of 1.900V, 20 kHz.
10. Temporarily replace the back cover of the multimeter.
11. Connect the AC calibrator to the V·Ω and COM Input Connectors, and note the reading. Ensure that the COM or "low" side terminal of the AC calibrator is matched with the multimeter COM terminal.
12. Remove the multimeter back cover and again note the Digital Display. The difference between the first and second readings is the "error voltage."
13. Adjust trimming capacitor C2, as identified in Figure 20, until the Digital Display reads a number equal to 1.900 plus the "error voltage."
14. Replace the multimeter back cover and secure with the four screws.
15. Verify that the Digital Display reads 1.900 ±20 digits.
16. Disconnect the AC calibrator.

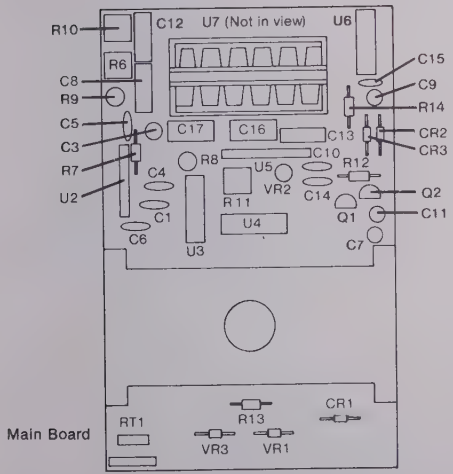
6.4 TROUBLESHOOTING

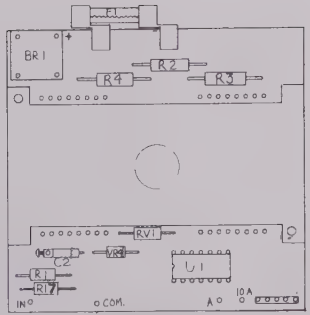
Except for the replacement of the battery or fuse, repair of the multimeter should be performed only by the Beckman Service Center or by other qualified instrument service personnel.

CAUTION

The CMOS multiprocessor chip is subject to damage created by electrostatic discharge. This component should be handled only by qualified personnel equipped with antistatic grounding devices.

If the multimeter is not performing properly, the following steps should be taken before returning it for warranty repair.





Piggyback Board
(Inside View)

NOTE
R1 is Located Under
the Battery Cradle

Figure 21. Components Locator for TECH 330 Model

1. Check the battery and fuse connections.
2. Check to see that the Function/Range Switch is in the correct position for the type of parameter and range of values being measured, and that the measurement value is within the capability of the multimeter.
3. Review and comply with the operating instructions contained in Section Four of this instruction manual.
4. Inspect the test leads for breaks or cracks, and ensure that the test leads are inserted fully into the input connectors.
5. Check to see that the ambient environment in which the multimeter is being used is within specifications given in Section Two of this instruction manual.
6. If the decimal point in the Digital Display is blinking, the battery is probably low. Replace battery, using procedure of Paragraph 6.2.2.
7. If the Digital Display is blank with the unit turned on, the battery is probably dead. Replace battery, using procedure of Paragraph 6.2.2.
8. If operation is normal in all functions and ranges except AC and DC current, the fuse is probably blown. Replace fuse, using procedure of Paragraph 6.2.3.

If the preceding steps do not remedy the problem, refer to Paragraph 6.1, Warranty and Non-Warranty repair service.

6.4.1 SERVICE MANUAL

A complete service manual is available from Beckman Instruments, Inc., for those users who desire to service their own multimeters. To obtain a copy of this manual, send $15.00* (postage and handling) in the form of a check, money order, or a purchase order made payable to Beckman Instruments, Inc. See shipping address in Paragraph 6.1.3.

6.5 MULTIMETER STORAGE

WARNING

If multimeter is to be stored at temperatures above 122°F (50°C), remove the battery.

*Prices are subject to change without notice.

This section provides a description of the Series 300 Multimeter accessories that are available from Beckman.

7.1 VINYL CARRYING CASE (VC-201)

The vinyl carrying case is constructed of durable, padded vinyl and will accommodate any Beckman Multimeter model. The case has room for the multimeter, instruction manual, and the TL-242 Probe Set without adding any unnecessary bulk. The back of the case has a handy belt loop.

7.2 DELUXE CARRYING CASE (DC-205)

Handsome, yet rugged, this case offers maximum protection for any Beckman Handheld Multimeter. Constructed of rigid, leather-grained vinyl, the deluxe case has inside compartments for storing the multimeter, TL-242 Probe Set, and the instruction manual.

7.3 HIGH VOLTAGE PROBE (HV-211)

The HV-211 High Voltage Probe extends the DC voltage measurement capability of any Beckman Multimeter to 50 kV. This accessory is essential for television and CRT terminal service where second anode voltages must be measured. This probe contains a precision 1000:1 resistor divider that scales high voltages down to a level that the multimeter can handle safely. The high input impedance of the probe minimizes circuit loading and assures accurate measurements.

7.3.1 HV-211 HIGH VOLTAGE PROBE SPECIFICATIONS

VOLTAGE RANGE
0 TO ±50 kVDC (NOT VAC)
INPUT RESISTANCE
1000 MΩ
DIVISION RATIO
1000 to 1
ACCURACY
±2% at 25 kV, changes linearly to 8% at 50 kV
MAXIMUM INPUT
±50 kVDC or peak AC

7.3.2 OPERATION WITH HV-211 HIGH VOLTAGE PROBE

WARNING

The HV-211 High Voltage Probe is used to measure potentially lethal voltages. Always disconnect power and discharge voltage source before connecting or disconnecting the High Voltage Probe.

When the High Voltage Probe is used, the probe replaces the standard test leads. The probe is connected to the multimeter in the same manner as the TL-242 Probe Set leads, and measurements are made as described in Paragraph 4.3.1 except that, because the probe is a precision 1000:1 divider, the Digital Display readings will be in kilovolts. A measured value of 50 000 volts will therefore read + 50.0 with the Function/Range Switch in the 200 DCV position.

7.4 RF PROBE (RF-221)

The peak detecting RF-221 RF Probe extends the AC voltage measuring capability of any Beckman Multimeter to 200 MHz. The RF Probe provides a DC voltage that is calibrated to equal the RMS value of a sine wave.

7.4.1 RF-221 RF PROBE SPECIFICATIONS

FREQUENCY RANGE
2 kHz to 200 MHz
ACCURACY
± (1% input + 50 mV), from 2 kHz to 10 MHz
± 1 dB from 10 MHz to 100 MHz
± 6 dB from 100 MHz to 200 MHz
MAXIMUM READING
25 VRMS
RESPONSE
Peak sensing, RMS calibrated
INPUT IMPEDANCE
1.5 mΩ in parallel with 7 pF
OVER VOLTAGE PROTECTION
130 VRMS at 60 Hz or 250 VDC

7.4.2 OPERATION WITH RF-221 PROBE

The RF-221 RF Probe is connected to the multimeter in the same manner as the TL-242 Probe Set leads. Measurements are made as described in Paragraph 4.3.1. Use appropriate DCV range from 200 mV to 200 V and read voltage signal directly in volts RMS.

7.5 AC CURRENT CLAMP (CT-231)

The CT-231 AC Current Clamp extends the AC current measurement capability of any Beckman Multimeter to 150 amperes without breaking the circuit under test. The 1000:1 current transformation allows direct reading in amperes when used with the 200 mA AC current range of the multimeter.

7.5.1 CT-231 AC CURRENT CLAMP SPECIFICATIONS

RANGE
10 to 150A RMS AC
FREQUENCY RANGE
30 Hz to 1 kHz
ACCURACY
±2% (60 Hz)
±3% (50 Hz to 1 kHz)
DIVISION RATIO
1000:1
CIRCUIT-TO-GROUND VOLTAGE
1000 VRMS maximum
MAXIMUM CONDUCTOR SIZE
0.45 inch (11.4 mm)

7.5.2 OPERATION WITH CT-231 AC CURRENT CLAMP

The CT-231 AC Current Clamp is connected to the A and COM Input Connectors of the multimeter in place of the TL-242 Probe Set leads. The jaws of the current clamp are placed around one of the current carrying conductors. With the multimeter in the 200 mA ACA position, current is read directly in amperes.

7.6 AC CURRENT CLAMP (CT-232)

The CT-232 AC Current Clamp extends the AC current measurement capability of any Beckman Multimeter to 1000 amperes by use of a 1000:1 current transformer. The clamp-on design permits AC current measurements without breaking the circuit under test.

DIVISION RATIO
1000:1
CIRCUIT-TO-GROUND VOLTAGE
1000 VRMS maximum
MAXIMUM CONDUCTOR SIZE
2.125 inches (54 mm)

7.6.2 OPERATION WITH CT-232 AC CURRENT CLAMP

The CT-232 AC Current Clamp is connected to the A and COM Input Connectors of the multimeter in place of the TL-242 Probe Set leads. The jaws of the current clamp are placed around one of the current carrying conductors. With the multimeter in the 2A ACA position, the displayed value is multiplied by 1000 to obtain measured current in amperes.

7.7 DELUXE TEST LEAD KIT (DL-241)

The specially designed Beckman DL-241 Deluxe Test Lead Kit comes in a handy vinyl case. The kit includes a complete assortment of probe tips for every measurement application. The kit includes the following tips: alligator clips, spade lugs, banana tips, phone tips, and needle tips. All tips will screw into the standard test leads. A Beckman TL-242 Probe Set is also included with the Deluxe Test Lead Kit.

7.8 TEMPERATURE/VOLTAGE CONVERTER (TC-253)

The TC-253 converts K-type thermocouple voltages for use with any Beckman DMM. It interfaces between the DMM and any K-type thermocouple or any probe using a standard K-type miniature or subminiature connector. The display reads in degrees C or F, which is switch-selectable.

7.8.1 TEMPERATURE/VOLTAGE CONVERTER SPECIFICATIONS

Accuracy:* 22°C ±3°C Ambient

TEMPERATURE RANGE		ACCURACY
°C	°F	
−50° to −10°	−58° to +14°	1.2% rdg. + 2.5°C or 4.5°F
−10° to +200°	+14° to +392°	0.5% rdg. + 1.5°C or 2.7°F
+200° to +500°	+392° to +932°	0.7% rdg. + 1.5°C or 2.7°F
+500° to +900°	+932° to 1652°	1.4% rdg. + 1.5°C or 2.7°F

*For total measurement accuracy, include error due to meter and thermocouple.

7.8.2 OPERATION WITH TC-253 TEMPERATURE/VOLTAGE CONVERTER

1. Plug TC-253 into V-Ω and COM inputs of multimeter.
2. Plug in Type-K thermocouple connector at input, switch to °C or °F.
3. Select appropriate Vdc range and read display in degrees.

7.9 DELUXE CARRYING CASE (DC-207)

Handsome yet rugged, this case offers maximum protection for any Beckman Handheld Multimeter and is designed to permit in-case operation. Constructed of rigid, leather-grained vinyl, the deluxe case has inside compartments for storing the instrument, test lead set, the operator's manual, and an extra compartment for a current clamp or small tools.

7.10 AC CURRENT CLAMP (CT-234)

This accessory extends the ac current measurement capability of any Beckman Multimeter to 200 amperes. The clamp-on design permits ac current measurements without breaking the circuit under test.

7.10.1 AC CURRENT CLAMP SPECIFICATIONS

CURRENT RANGE
0A to 200A RMS

FREQUENCY RANGE
50 Hz to 2000 Hz

TEMPERATURE RANGE
15°C to 35°C

ACCURACY*

FREQUENCY	RANGE	
	2 AMP	20 AMP AND 200 AMP
60 Hz	±4%	±4%
50 Hz to 1000 Hz	±7%	±6%
1000 Hz to 2000 Hz	±8%	±7%

*Percentage of fullscale with conductor centered. Add DMM ac volt accuracy.

TEMPERATURE INFLUENCE
2-amp range: Less than ±3% of full range error between 15°C and 35°C.

20-amp and 200-amp ranges: Less than ±0.5% of full range error between 15°C and 35°C.

CIRCUIT-TO-GROUND VOLTAGE
600V RMS maximum

MAXIMUM CONDUCTOR SIZE
1.37 inches (35 mm)

7.10.2 OPERATION WITH CT-234 CURRENT CLAMP

1. Connect the leads to the V-Ω and COM inputs of your multimeter.
2. Set the range switch to the appropriate ampere range. If the magnitude of the current being measured is unknown, start with the 200 ampere range.
3. Set the range of the multimeter to the appropriate range according to the following chart:

Ampere Range	Multimeter V ac Range
2 amps	200 mV ac
20 amps	2 V ac
200 amps	20 V ac

4. Snap the jaws of the current clamp around one of the current-carrying conductors. Make sure that the jaws are tightly clamped.
5. Center the conductor between the two closed jaws.

NOTICE

If the jaws of the Model CT-234 ac current clamp are clamped around both conductors (as in a power cord), opposing magnetic fields will cancel each other and cause the current clamp to be ineffective.

6. Read the value indicated on the digital multimeter. The current in amperes is ten times this value.

7.11 FUSE PACK (FP-260)

Each pack contains four 2A/600V fuses for the Beckman Digital Multimeters.

www.manualsplus.com

1033021

BECKMAN

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Corporate Offices
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